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OPERATING INSTRUCTION MANUAL
MODEL T222C
SIGNALLING TEST SET

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# OPERATING INSTRUCTION MANUAL
# MODEL T222C
# SIGNALLING TEST SET

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CONTENTS


| SECTION | DESCRIPTION | PAGE |
|---|---|---|
| 1.0 | General | |
| | 1.1 Description | 1-1 |
| 2.0 | Specifications | |
| | 2.1 Receive Section | 2-1 |
| | 2.2 Send Section | 2-1 |
| | 2.3 Environmental | 2-2 |
| | 2.4 Standard Power Input | 2-2 |
| | 2.5 Optional Power | 2-2 |
| | 2.6 Mechanical | 2-3 |
| 3.0 | Panel Controls and Connections | |
| | 3.1 General | 3-1 |
| | 3.2 Input/Output Connections | 3-2 |
| | 3.3 Pulse Generator Controls | 3-4 |
| | 3.4 Display and Display Controls | 3-5 |
| | 3.5 Send Interface Controls | 3-6 |
| | 3.6 Rec Interface Controls | 3-7 |
| | 3.7 Supervision Controls | 3-7 |
| | 3.8 Misc. Send Controls | 3-7 |
| 4.0 | Operation | |
| | 4.1 ac Power | 4-1 |
| | 4.2 dc Power | 4-1 |
| | 4.3 Display Controls | 4-1 |
| | 4.4 Pulse Generator | 4-2 |
| | 4.5 Loop Operation | 4-2 |
| | 4.6 SF Operation | 4-5 |
| | 4.7 E&M Operation | 4-10 |
| | 4.8 DX Operation | 4-15 |
| 5.0 | Operational Checks | |
| | 5.1 General | 5-1 |
| | 5.2 Initial Conditions | 5-1 |
| | 5.3 Pulse Generator and Display Checks | 5-1 |
| | 5.4 LOOP Checks | 5-5 |
| | 5.5 E&M Checks | 5-7 |
| | 5.6 SF Checks | 5-9 |
| | 5.7 DX Checks | 5-10 |
| | 5.8 Dialed Number Storage Checks | 5-11 |
| 6.0 | Appendix | |
| | 6.1 General | 6-1 |

MODEL T222C
SIGNALLING TEST SET

# 1.0 GENERAL

## 1.1 Description

1.1.01 The T222C is a portable, general purpose signalling test set, primarily designed to test signaling systems which transmit information in a serial mode. Included in this group are DC systems such as loop, E&M, etc., and one tone system, which is "Single Frequency" or SF system.

1.1.02 Included in the T222C are independently functioning send and receive sections, each with its own circuits which provide the proper line interface according to the type of supervision selected.

1.1.03 The set may be used either as a portable with a carrying case and cover, or as a rack mounted instrument without the portable carrying case.

1.1.04 Either instrument may be operated from 115V or 230V ac 50 to 60 Hz, or optionally operated from 48V central office battery.

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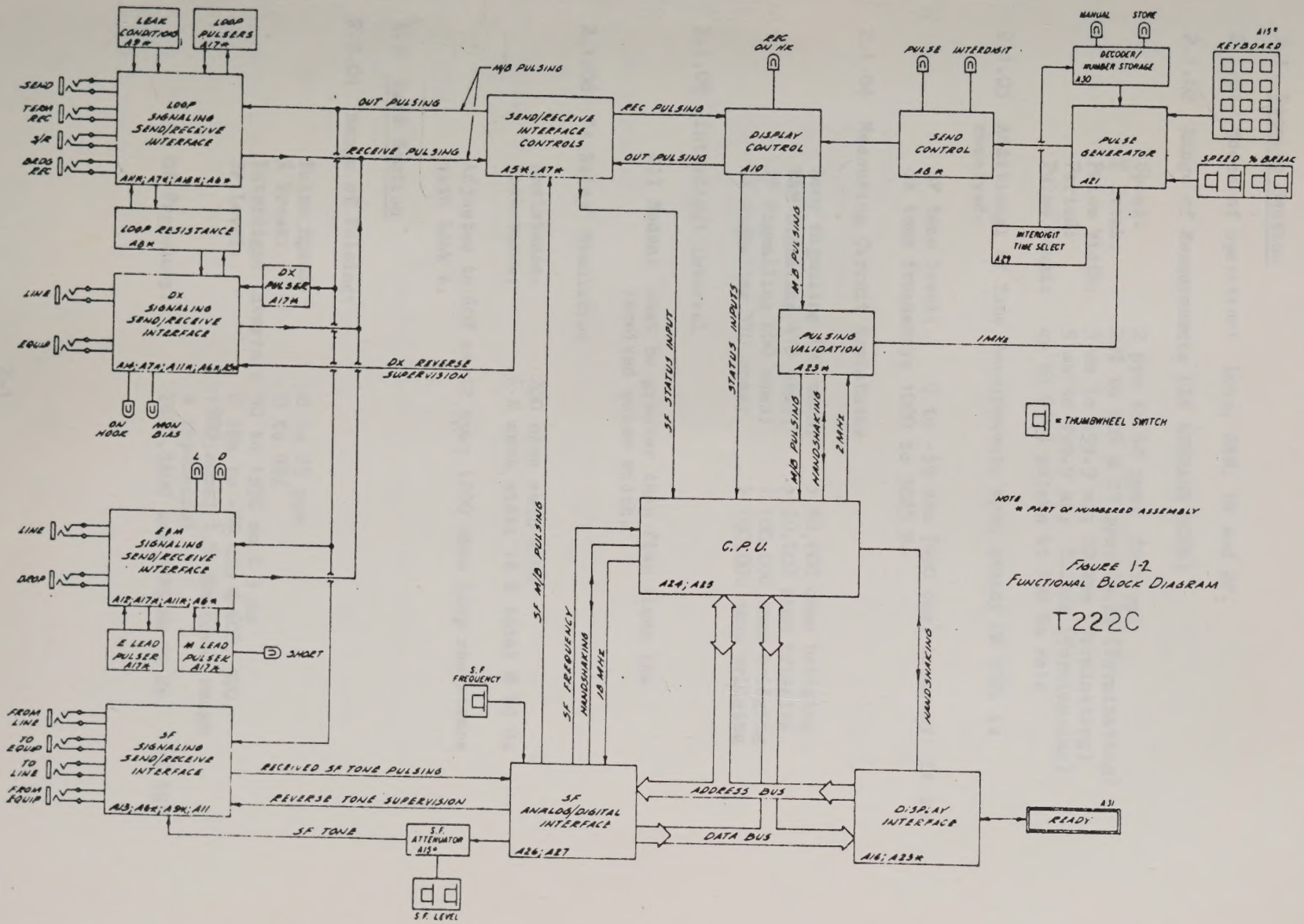



FIGURE 1-2
FUNCTIONAL BLOCK DIAGRAM

T222C

## 2.1 Receive Section

2.1.01 Modes of operation: Loop, E&M, DX and SF.

2.1.02 Range of Measurements (IN AVERAGE MODE)

| | |
|---|---|
| Speed: | 2 pps to 50 pps; ±0.2 pps |
| % Break: | 20% to 90% @ 25 pps; ±0.2% (Terminating) |
| Pulse Width: | 3 ms to 599.9 ms; ±0.2ms (Terminating) |
| Period: | 5 ms to 999.9 ms; ±0.2ms (Terminating) |
| Pulse Count: | up to 9999 pulses at 150 Hz rate |

2.1.03 Additional SF Tone Measurements when steady ON HOOK is received.

| | |
|---|---|
| SF tone level: | 0 to -39 dBm (900 ohm) Accuracy ±1 dB |
| SF tone frequency: | 1000 to 3825 Hz |

2.1.04 Measuring Circuit Resistance

| | |
|---|---|
| Loop Signaling 400 ohms; | > 60,000 ohms bridging |
| E&M Signaling 470 ohms; | > 20,000 ohms bridging |
| SF Signalling 600 ohms; | > 100,000 ohms bridging |
| DX Signaling 370 ohms; | > 100,000 ohms bridging |

2.1.05 Interdigit Interval

All Modes: must be greater than five times the received pulse width.

2.1.06 "A Relay" Simulation

| | |
|---|---|
| Resistance: | 200 ohms each side |
| Inductance: | 6 H each side; 14 H total @ 60 Hz |

Adjusted to 60% at 12 pps; 1200 ohms loop resistance with Leak A.

## 2.2 Send Section

2.2.01 Range of Pulsing:

| | |
|---|---|
| Pulse Speed: | 0 to 29 pps |
| % Break: | 0 to 99% |
| Interdigit Interval: | 50 to 1550 ms ± 3 ms |
| SF Level: | 0 dBm to -39 dBm @ 600, 900, 1200 ohms; ±.5 dBm (over range & impedance) |
| SF Frequency: | 2600,3400 and 3825 Hz ±2 Hz, <2% THD |

2.2.02 **Leak Conditions:**

A, B, C, D, D1, SF1

2.2.03 Send Circuits:

| | |
|---|---|
| LOOP (DRY) | 25 ohms + ADD LOOP RES switches<br>Current limited to approximately 150 mA |
| LOOP (B&G) | 300 ohms + ADD LOOP RES switches |
| E&M | Less than 25 ohms<br>Current limited to approximately 150 mA on M lead; E lead current 200 mA maximum |
| DX | 370 ohms + ADD LOOP RES switches |
| SF | 600, 900, 1200 ohms, switch selectable. |

2.2.04 Send Functions

Continuous train of pulses
Single digit
Stored Digits (Max. of 16)
Continuous repeating of one digit
Push button dialing of digits
Steady ON HOOK
Steady OFF HOOK

## 2.3 Environmental

| | |
|---|---|
| Operating Temperature Range: | 0 °C to 50 °C |
| Humidity: | 95% at 35 °C<br>40% at 50 °C |
| Storage Temperature: | -40 °C to 75 °C |
| Altitude (non-operating): | 30,000 feet |

## 2.4 Standard Power Input

95 - 135V or 200 - 260V ac 50/60 Hz, switch selectable on rear panel.

50 watts maximum
Fused for 2 amperes

## 2.5 Optional Power Input

44 - 52.5 dc Central Office Battery

1 1/2 amperes maximum

Not fused

## 2.6 Mechanical

Portable Unit - 18" W x 10" H x 14" deep, including cover
Weight - 30 lbs. Specify T222C when ordering.

Rack Mounted Unit - 19" W x 10" H x 12" deep
Weight - 25 lbs. Specify T222CR when ordering.

## 3.1 General

3.1.01 This section describes the functions of each switch, lamp and jack located on the front panel of the Model T222C. This description will be broken down into various sections which relate to power, sending and receiving, and interface selection.

All the push buttons on the front panel are color coded for ease of user operation. The grey buttons are used for all modes of operation. These are used to select such functions as PPS, PERIOD, direction of pulsing or receiving, etc. The green buttons select special functions that will override the functions selected under the grey code. All black buttons apply to functions selected for use in LOOP sending or receiving. The blue buttons are used for selection of E&M functions. The white buttons are used for SF and the cream are used for DX.

3.1.02 Push button action definitions --

(1) Push-push: The switch remains engaged when pressed and must be pressed again to release. The switch function continues as long as the switch remains engaged.

(2) Push-push with lockout: Has the same effects as the push-push action for individual switches except that related switches cannot be engaged simultaneously.

(3) Interlocking: Consists of a group of two or more switches. When any switch in a group is pressed, it automatically releases any other switch that was engaged. The switch function continues until released by pressing another switch in that group.

(4) Interlocking with lockout: Has the same effects as the interlocking action except that no two interlocking buttons may be pressed at one time.

(5) Momentary: The switch remains in only as long as it is pressed. The switch returns to its original position as soon as pressure is removed.

(6) Engaged: The "in" or low profile position.

(7) Released: The "out" or high profile position.

## 3.2 Input/Output Connections

3.2.01 ac Power Receptacle -- This is a 3-prong male jack recessed in the rear panel of the test set. The line cord supplied with the test set supplies ac power to the test set through this connection. Not part of dc powered T222C.

3.2.02 115/230 Switch -- This switch allows the selection of either 115V primary voltage or 230V primary. The switch is located just under the ac Power receptacle on the rear panel. Not part of dc powered T222C.

3.2.03 Ground Binding Post -- On the rear panel near the center is a 5-way binding post which may be used to supply office ground if required. The set is normally grounded through the ac power cord. If the ground is not supplied through the power cord, the Ground Binding Post must be used to supply signal ground. Not part of dc powered T222C.

3.2.04 Vdc Terminal Strip -- This terminal strip provides connections for power on the 48 Vdc powered T222C. The SIG terminal provides the connection for the -48 Vdc used for line signaling functions while the PWR terminal provides the connection for -48 Vdc test set power.

3.2.05 Fuse -- The snap-action fuse holder is located on the lower right hand corner of the front panel. The 2A slow blow fuse provides the protection for the 115/230 volt ac and the -48 vdc PWR inputs.

3.2.06 Power Switch -- A toggle type power switch is used as the on-off switch for powering the set. The switch is located just to the left of the fuse holder.

3.2.07 Jack Field -- The lower left corner of the front panel has a field of 12 jacks. The jacks are used to make connections to the circuit to be tested. The jacks are all W.E. Type 310. The field is further broken down into 4 sections, LOOP, E&M, SF, and DX. The jacks under each section are used to make connections to circuits under test for related types of pulsing only; for example, the TERM REC Jack under the LOOP section is used only for Loop type signaling.

3.2.08 Loop Jacks -- On the most left hand side of the jack field are 4 jacks under the bracket designated LOOP. These jacks are used for making connections to the Loop pulsing circuits.

1. SEND -- This jack is used for connecting a circuit where Loop pulsing is required. The tip and ring supply either Loop closures, Battery and Ground pulsing or Loop Closures with Ground Start depending on selection of Send Interface Controls.

2. TERM REC -- This jack is used for all terminated Loop receiving. The tip and ring are connected to either the simulated A relay or through a resistive battery feed for direct measurements. The selection of different receive modes is in response to the Receive Interface Controls.

3. S/R -- This jack has the tip and ring connected in parallel with the Send jack, the sleeve is connected to the battery referenced side of the loop receiver so ground and open pulsing may be detected. The jack has uses in the testing of some pulse repeating relays and toll test pulsing requirements.

4. BRDG REC -- This jack is used to make measurements on a working loop on a bridging basis. When a plug is connected into this jack the other loop receivers are overridden so this jack must be vacant if the TERM REC jack is to be used. Any circuit that is connected to this jack must have dc supervision (wet loop) in order for the Bridging Receiver to work. The BRDG REC jack is intended to be used for dialed number or pulse count display.

3.2.09 E&M Jacks -- Just to the right of the Loop jacks are two jacks designated LINE & DROP.

1. LINE Jack -- This jack is to connect to the line side of the E&M circuit. The M lead pulser is on the ring of this jack and the E lead detectors are on the tip of this jack.

2. DROP Jack -- This jack is used to connect to the Drop side of an E&M circuit. The E lead pulser is on the tip of this jack and the M lead detectors are on the ring of this jack.

3.2.10 SF Jacks -- These four jacks are located under the bracket designated SF. These are used - in pairs - to make connections to the SF circuit. The FROM LINE and TO EQUIP jacks are the receive side jacks or the +7 TLP jacks. The other pair, TO LINE and FROM EQUIP are transmit side or the -16 TLP.

3.2.11 DX Jacks -- The last two jacks are used to connect to the DX (Duplex Signaling) system. In a dc signaling circuit the closest DX set is designated the EQUIP side and the more distant DX set is the LINE side.

1. LINE -- This jack is used to connect into the circuit toward the more distant DX set. The tip is the A lead and the ring is the B lead.

2. EQUIP -- This jack is used to connect into the circuit toward the closer of the two DX sets.

## 3.3 Pulse Generator Controls

3.3.01 The controls which are used to initiate the outpulsing are located on the right hand side of the Test Set. These controls are used to set the characteristics of the outgoing pulsing.

3.3.02 ADJUST SEND SIGNAL -- On the upper right corner of the set are three sets of thumbwheel switches, two of which are labeled SPEED (PPS) and % BREAK. These two sets of thumbwheel switches are used to select the characteristic of the sending signal. The SPEED thumbwheels select pulses per second from 1 to 29 in one pps increments. The % BREAK thumbwheels adjust from 1 - 99% BREAK. If 0 pps or 0% BREAK is selected the pulse generator does not function since this condition is equivalent to a steady off hook.

3.3.03 Keyboard -- The keyboard is a 3 by 4 matrix with digits 0 - 9 and two special function keys; the "*" and the "#". Two modes of operation for sending digits are available; a MANUAL mode and a STORE mode. The mode is changed by pressing "*" for 2 seconds and is indicated by one of two LEDs.

a. In the MANUAL mode, digits are immediately outpulsed as they are entered. Pressing "#" will result in the previous entry being repeated continuously with a delay between digits equal to the setting on the INTERDIGIT time switch. A new digit may be entered during outpulsing while the interdigit light is on.

b. In the STORE mode, any number of up to 16 digits may be entered on the keyboard. The entire stored number is outpulsed when "#" is pressed and may be repeated as many times as desired. Before storing a new number, the "*" key should be pressed once to clear internal counters.

3.3.04 INTERDIGIT TIME (ms) -- the send interdigit time is set on the INTERDIGIT TIME (ms) push buttons; the settings are additive. The send interdigit interval is programmable from 50 ms to 1550 ms in 50ms increments.

3.3.05 SEND CONTROL:TRAIN,DIGIT,ON HK,OFF HK -- Four push buttons having interlocking withlockout action are used to select the output mode of the Pulse Generator. With the SEND CONTROL:TRAIN button engaged, gaged the Pulse Generator continuously generates pulses characteristic of the SPEED and % BREAK thumbwheel settings. The train of pulses is initiated by pressing any digit (0-9) while in the MANUAL mode. With the SEND CONTROL:DIGIT button engaged, the Pulse Generator pulses are determined by the SPEED and %BREAK thumbwheel settings and the keyboard inputs. With the ON HK button engaged the Pulse Generator output is steady On Hook; with the OFF HK button engaged, the Pulse Generator output is a steady Off Hook (idle).

3.3.06 PULSE & INTERDIGIT Lamps -- The Pulse Generator section has two indicator Lamps. These lamps, when lighted, indicate the operational status of the Pulse Generator. The PULSE Lamp, which is a green LED, indicates when the Pulse Generator output is in the on hook condition. The INTERDIGIT Lamp, which is a red LED, indicates the interdigit interval.

## 3.4 Display & Display Controls

3.4.01 The Display and Display Controls are located in the upper left hand corner of the Test Set.

3.4.02 The display is a 32 character alphanumeric device, capable of displaying a full 64 character ASCII subset. It is used to display all of the measured parameters as selected by the FUNCTION and MODE controls. Appropriate labels -- such as; 60% BRK, 8 PULSE, 100.1 PER -- are added to the measured values to help identify what is actually being measured.

3.4.03 DISPLAY Controls -- The Display Controls are located directly underneath the Display and are broken down into two groups, FUNCTION and MODE.

3.4.04 FUNCTION:DIALED NUMBER,COUNT PULSES -- Under the FUNCTION grouping, the priority button is the DIALED NUMBER; selection of this button supersedes any other selection in this group. In this mode the display presents the digits as dialed. Up to 26 digits can be entered and displayed. After receipt of an entire dialed number, the interdigit intervals for the first sixteen received digits can be displayed by repetitive presses of the MODE PULSE DATA button. Interdigit Times of greater than 3999 msec. will be displayed with an over-range indicator (>3999). The next button, labeled COUNT PULSES, has the next level of priority. This button which has lockout with the DIALED NUMBER button, causes the test set to display the updated pulse count continuously as received through the receive interface. When COUNT PULSES is selected, the count accumulates from the time the CLEAR button is pressed, or from the time the word READY appears on the screen, until the CLEAR button is engaged again.

3.4.05 FUNCTION:% BRK, WIDTH, PPS, PERIOD -- With the COUNT PULSES and DIALED NUMBER buttons both released, then the control of the display function reverts to selection of % BREAK or WIDTH, which are interlocked with each other, and the PPS or PERIOD buttons, which are also interlocked with each other. If no buttons are engaged (of these four), then % BREAK and PPS are displayed. To avoid confusion, each entry into the display is labeled with its appropriate function.

3.4.06 MODE -- Under the DISPLAY CONTROL to the right are a group of buttons caled MODE. These buttons select the mode in which the previously selected functions will be displayed.

3.4.07 MODE:MEAS:REC, PULSE GEN -- These two interlocked buttons select the source of the pulsing input to the measuring circuits. When the REC button is engaged, the pulsing from the receive interface is selected. When the PULSE GEN button is engaged, the measuring circuit input is connected to the output of the pulse generator without interrupting the pulsing to the Send Interface. The PULSE GEN button may therefore be used to verify the pulse generator operation during actual pulsing of a circuit.

3.4.08 MODE:AVG, UPDATE -- These two buttons are interlocked. The AVG button causes the Test Set to display a reading averaged over a number of incoming pulses. Normally this number is 9 and is obtained by having the far end pulse ten pulses or a continuous pulse train in which case the Test Set averages every 10 pulses, continually updating every tenth. The UPDATE mode causes the set to display the measured parameters of each pulse as it comes in.

NOTE: A minimum of two pulses in the AVG mode or three pulses in the UPDATE mode must be received to display any parameters. In the AVG mode, if fewer than ten pulses are received, the Test Set averages the number of pulses received minus one. If eight pulses are received, the first seven pulses are averaged.

3.4.09 MODE:PULSE DATA -- This momentary action button performs two functions. In the DIALED NUMBER DISPLAY mode, pressing PULSE DATA will result in a display of the interdigit time between the received digits (up to 16). In % BRK, PPS, WIDTH and PERIOD display modes, pressing PULSE DATA will result in a display of the selected parameters (i.e., % BRK and PPS) for each pulse in a received digit. In addition, the data may be re-displayed in terms of any of the four pulse parameters by selecting the desired parameters and repetitively pressing PULSE DATA.

3.4.10 MODE:CLEAR -- This button is a momentary type action. The CLEAR button may be pressed at any time, and results in a return of the Test Set to initial conditions with all registers clear and the word READY on the display. Operation of the CLEAR button has no affect on the sending of pulses; it affects only receive data.

3.4.11 REC ON HK Lamp -- This lamp, a red LED, is located to the left of the DISPLAY CONTROL buttons. This lamp when lighted indicates an On Hook is being received from the selected interface. The lamp is also a visual indication of pulsing that is being sent to the Measuring Circuits for display. If the REC ON HK lamp is not pulsing, then the Measuring Circuits are not receiving any pulses for display.

3.5 SEND INTERFACE Controls

3.5.01 General -- The Send Interface buttons are two vertical columns of four and five buttons each near the center of the front panel. These buttons select the type and direction of outpulsing.

3.5.02 SEND INTERFACE CONTROLS:GROUND START,LOOP,E&M,SF,DX -- These five buttons are interlocked with lockout and are used to select the type of outpulsing. Further description of these controls is given in each operational section.

3.5.03 SEND INTERFACE CONTROLS: B&G/NORM,TWD LINE,TWD DROP/EQ,ADD RES - The B&G/NORM button is a push-push type and selects either Battery and Ground or normal loop closures for loop pulsing. The TWD LINE and TWD DROP/EQ buttons are interlocked and select the sending direction for the pulsing. The ADD RES is a push-push type used in DX to add loop resistance in the pulsing output.

## 3.6 REC INTERFACE Controls

3.6.01 The Receive Interface Controls are on the left hand side of the panel and are made up of two vertical columns of four buttons each. These are used to select the type of interface to receive the pulsing.

3.6.02 REC INTERFACE:LOOP,E&M,SF,DX -- These four buttons are interlocked with lockout and are used to select the type of interface for receiving. More specific information will be covered in each operational section.

3.6.03 REC INTERFACE:"A" RLY/DIRECT,FROM LINE,FROM DROP/EQ,STATUS -- The "A" RLY/DIRECT button is a push-push type and is used to select either the simulated "A" type relay mode or the direct mode of loop measurement. The FROM LINE and FROM DROP/EQ buttons are interlocked and are used to select the direction from which the pulses are received. These last two buttons also control the receive threshold of the SF receive interface.

STATUS is a momentary type button and is used in the DX mode to determine the correct orientation of the A & B leads.

## 3.7 Supervision Controls

3.7.01 Between the Send Interface and Receive Interface buttons are three groups of horizontal buttons. These buttons are the supervision controls and are used to establish the supervision each interface provides its associated jacks. The top group of six buttons are used for E&M supervision; the middle six buttons are used for SF supervision; and the bottom five buttons are used for DX supervision. The buttons will be further explained in each operational section.

## 3.8 Misc Send Controls

3.8.01 ADD LOOP RESISTANCE -- Six push-push type buttons are used to select the amount of loop resistance to be added to the output of either the loop pulser or the DX pulser. Engaging the buttons adds the amount marked above the button to the output with one half in the ring and the other half in the tip. For example, if the 800 button is engaged, the tip has 400 ohms and the ring has 400 ohms.

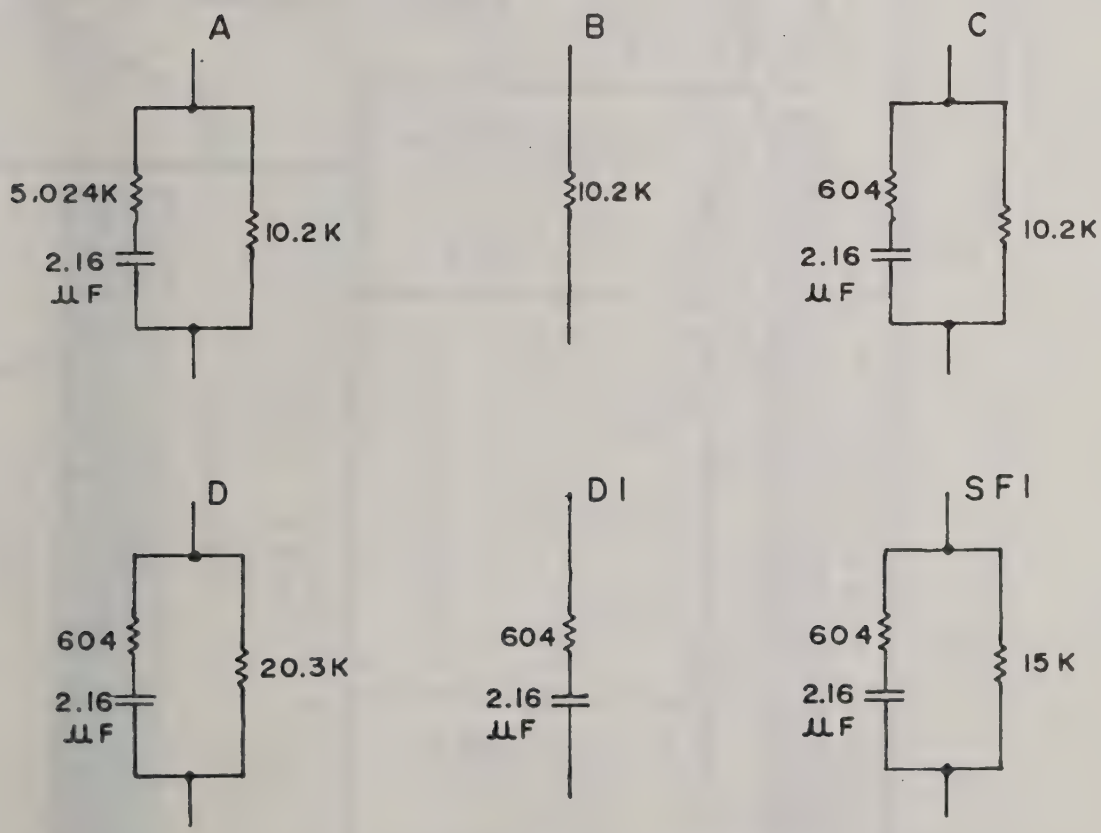
3.8.02 SF Imp -- These three buttons are interlocked and are used to select the output impedance of the SF interface.

3.8.03 ADJUST SEND SIGNAL:SF LEVEL -- The SF level thumbwheel switches set the output level of the SF to be sent. The switches are located in the upper right hand corner of the front panel.

3.8.04 ADJUST SEND SIGNAL:SF FREQ -- The SF FREQ thumbwheel selects one of three or an optional 4th frequency for SF send functions.

3.8.05 SHORT Lamp -- The SHORT lamp which is located just above the ADD LOOP RESISTANCE buttons is used to indicate when excessive current is being drawn by a sending circuit, for example, a ground on the M lead.

3.8.06 LEAK COND -- The six buttons marked A thru SF1 are interlocked and the OUT is a push-push type action. The leak conditions are used in the loop pulser only. Send leak conditions are shown below. More information is in the Loop Section.




T222C LEAK CONDITIONS

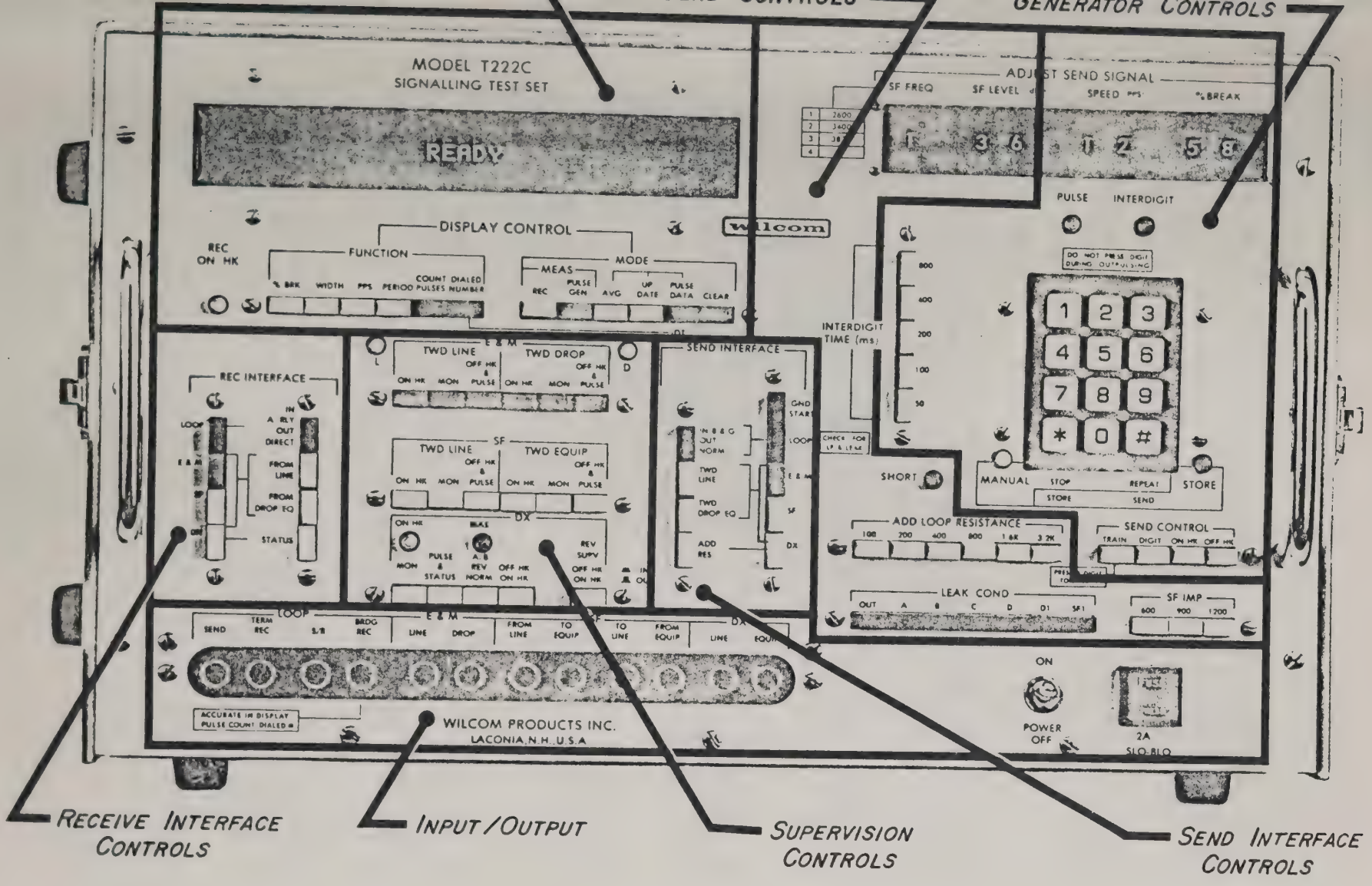



FIGURE 3-1
PANEL CONTROLS AND CONNECTIONS

## 4.1 ac POWER

4.1.01 The T222C is powered by either 115 or 230 volts ac. For operation, connect the line cord to the recessed male connector on the rear panel and set the voltage slide switch for the line voltage which is being used. Power is supplied to the Test Set by placing the POWER toggle switch in the ON position.

4.1.02 The Test Set is ready for operation as soon as power is applied. Detailed operation information is obtained by refering to the appropriate portions of Section 3 and Section 4.

## 4.2 dc POWER

4.2.01 When the T222C is equipped with the dc power option, -48 Vdc is connected to the SIG and PWR terminals on the rear panel. The GND terminal is connected to office ground. Power is supplied to the Test Set by placing the POWER toggle switch in the ON position.

4.2.02 The front panel fuse provides protection for the -48 Vdc PWR input terminal. The -48 Vdc SIG input terminal is not fused.

## 4.3 DISPLAY CONTROLS

4.3.01 The two buttons MEAS:REC/PULSE GEN, select the source of the pulsing to be measured. When the REC button is engaged, the pulsing from the REC INTERFACE is measured. When the PULSE GEN button is engaged, the output of the pulse generator is measured without interrupting the pulsing to the SEND INTERFACE.

4.3.02 The remaining ten DISPLAY CONTROLS provide six of the seven status inputs to the Central Processing Unit (CPU) to control the computation and display functions (the seventh is provided by the REC INTERFACE:SF button). Detailed functional descriptions are provided in Section 3.4 for each push button.

4.3.03 The CLEAR button, when pressed, initializes the status of the CPU. If CLEAR is pressed during a pulse train while the set is actively engaged in measuring, the set immediately returns to the measurement mode that it left when the CLEAR button was pressed. However, all previously stored data such as PULSE DATA, COUNTPULSES, etc., are erased and begin accumulating anew from that point.

4.3.04 When the Test Set is operating in the AVG or UPDATE mode, a minimum of two pulses must be received to display any parameters. In the AVG mode, if fewer than ten pulses are received the Test Set averages the number of pulses received minus one, i.e., if eight pulses are received, the first seven pulses are averaged.

4.3.05 If fewer than two pulses in UPDATE or fewer than three pulses in AVG mode are received the set returns to ready.

## 4.4 PULSE GENERATOR

4.4.01 The Pulse Generator controls determine the characteristics of the pulsing provided to the SEND INTERFACE controls for outpulsing. A crystal controlled time base is used in the pulsing circuits for high accuracy.

4.4.02 When either the E&M or the SF Supervision Control push button labeled OFF HK & PULSE is engaged, outpulsing is controlled by the Pulse Generator controls. These include:

1. SEND CONTROL
2. Keyboard (Manual - Store)
3. INTERDIGIT TIME (ms)
4. ADJUST SEND SIGNAL
   (a) SPEED (PPS)
   (b) % BREAK

4.4.03 The four SEND CONTROL push buttons (TRAIN, DIGIT, ON HK and OFF HK) each send a series of pulses of the required characteristics to the circuit being tested. The keyboard is used for dialed number entry as well as pulsing control. Two modes of operation are available for sending digits - a MANUAL mode and a STORE mode. In the STORE mode up to 16 digits may be stored and dialed repeatedly. The send interdigit interval (INTERDIGIT TIME) is programmable from 50 ms to 1550 ms in 50 ms increments. Thumbwheel switches are used to control the pulse SPEED from 0 to 29 pps in one pps increments, and the % BREAK from zero to 99% in 1.0% increments.

4.4.04 The various systems for sending a pulsing signal are selected by the SEND INTERFACE which provides Loop, Loop/Ground Start, E&M, SF or DX modes.

## 4.5 LOOP OPERATION

4.5.01 General -- The Test Set has the provisions for general loop outpulsing and detection. The send section can outpulse on a loop closure or Battery and Ground basis. A momentary action push button applies a ring ground when pressed for ground start operation. The loop detector receives on a terminated or bridging basis. The outpulsing is performed by solid state pulsers which reproduce the operation of relays without the inherent variation in operation. The solid state loop detectors have two types of terminated receivers; the inductor feed simulated "A" relay and the resistive feed direct measurements.

4.5.02 Description of Controls -- This section cover the controls that are used for general loop pulsing and receiving. The controls that are unique to loop are color coded black.

a. REC INTERFACE -- The following two buttons are used for Loop Receiving:

   1. LOOP -- This button connects the output of the selected loop detector to the measuring circuits for display.

2. "A" RLY/DIRECT -- This button selects the type of terminated receiver connected to the TERM REC Jack. When engaged, a receiver that simulates the operation of an "A" relay is connected to provide displayed readings based on the performance of a typical "A" relay. When released, a direct measuring receiver is connected to provide displayed readings of the actual signaling (open and closed) durations.

b. SEND INTERFACE -- The following two buttons are used for Loop Pulsing:

1. GROUND START -- This button applies a ground to the ring of the send loop jacks when pressed.

2. LOOP -- This button connects the output of the Pulse Generator to the selected loop pulser.

3. B&G/NORM -- This button selects the type of pulser connected to the LOOP SEND jack. When engaged, the Battery and Ground Pulser provides battery/open pulsing on the tip and ground/open pulsing on the ring. When released, a solid state device provides loop closures between the tip and ring.

c. ADD LOOP RESISTANCE -- The Loop Resistance buttons are located in the lower right hand side of the set. When a button is engaged, the value of the button is added to the loop pulsing circuit. For example, if 1200 ohms is to be added to the loop then the 400 and 800 ohm buttons should be engaged and all the others should be released.

d. LEAK COND -- The Leak Condition buttons are located under the Loop Resistace buttons. The Leak Condition buttons are interlocked so only one condition can be selected at a time. To put the condition in the loop pulsing circuit, the OUT button has to be released and the desired LEAK COND has to be engaged. By engaging the OUT button, the leak condition is removed from the circuit.

4.5.03 Bridging Loop Measurements

a. Bridging loop measurements are intended to be used on a circuit only to receive a dialed number or to check the supervision on a circuit without breaking the loop. To make the bridging loop measurements the following button is operated:

ENGAGE

REC INTERFACE:LOOP

b. The bridged circuit is plugged into the BRDG REC Jack. The REC ON HK Lamp shows the supervision or pulsing that is occuring on the circuit. By engaging the DIALED

NUMBER button under the DISPLAY CONTROL the number that is being dialed is displayed. The % BREAK may be displayed but the accuracy is degraded because of various loop conditions. The speed will be displayed with the measuring accuracy of the Loop Detector. The BRDG REC Jack must be vacant for terminated Loop measurements.

4.5.04 Terminated Loop Measurements

a. The T222C makes terminated loop measurements either in a direct reading mode or in a simulated "A relay" mode. To make the terminated loop measurements the following buttons are operated:

ENGAGED

REC INTERFACE:LOOP
REC INTERFACE:"A" RELAY/DIRECT (See Note)

NOTE: The "A" RLY/DIRECT button should be set to the position of the desired type of measurements.

b. The circuit to be tested is connected to the TERM REC Jack. The REC ON HK Lamp indicates the supervision or pulsing of the circuit. The Display Controls should be set for the presentation desired.

4.5.05 Loop Pulsing Measurements

a. Two types of loop pulsing are provided by the test set; normal loop closures, and battery and ground pulsing.

b. Normal Loop (Dry) -- To outpulse with loop closures the following buttons are operated:

| ENGAGE | RELEASED |
|---|---|
| SEND INTERFACE:LOOP | SEND INTERFACE:NORM/B&G |

1. The circuit to be pulsed is connected to the LOOP:SEND Jack. The LOOP S/R Jack has the same pulsing across its tip and ring. The two jacks are connected in parallel. The outgoing pulses are controlled by the Pulse Generator.

2. Ground Start circuits may be seized by pressing the GND START push button.

c. Battery & Ground -- In order to provide battery and ground outpulsing the following buttons are operated:

ENGAGED

SEND INTERFACE:LOOP
SEND INTERFACE:B&G/NORM

1. The circuit to be pulsed is connected to the LOOP:SEND Jack. The outgoing pulses are controlled by the Pulse Generator.

## 4.6 SF OPERATION

4.6.01 General -- The SF section of the Test Set interfaces an SF circuit at a 4-wire point in the office. The section has its own synthesizer with outputs of 2600, 3400 and 3825 Hz and is capable of sending SF tone at any of three impedances: 600, 900, or 1200 ohms. The sending level can be varied over the range from 0 to -39 dBm in 1 dB steps. The SF tone can be received in either a high impedance monitoring mode or a terminated 900 ohms mode.

a. When receiving SF pulsing, the Display Controls determine the information displayed on the alphanumeric readout.

b. When tone (ON HOOK) is received for longer than one second without interruption, the Test Set automatically measures and displays the LEVEL and FREQUENCY of the tone. The display measurement is updated every second until the tone disappears (OFF HOOK); at which time the last measurement is held and displayed. Control of the measurement and display automatically reverts to the Display Controls when SF pulsing is received.

4.6.02 Description of Controls -- This section covers controls that are used during SF pulsing or receiving and determine the direction for both operations. Controls which are unique to SF operation are color coded white.

a. REC INTERFACE -- The following three buttons are used for SF receiving.

1. SF -- This button, when engaged, connects the SF detector output to the measuring circuits for presentation on the display.

2. FROM LINE -- This button, when engaged, connects the SF detector to the SF:FROM LINE Jack and switches the SF receive threshold for rejection of tone less than -26 dBm (2600 Hz only).

3. FROM DROP/EQ -- This button, when engaged, connects the SF detector to the SF:FROM EQUIP Jack. Also, the receive sensitivity is increased to -40 dBm.

b. SEND INTERFACE -- The following three buttons are used for SF pulsing:

1. SF -- This button, when engaged, connects the output of the Pulse Generator to the SF Send Interface and Supervision controls.

2. TWD LINE -- This button, when engaged, connects the output of the SF Level control circuit to the SF Supervision Controls for gating by the Pulse Generator and connection to the SF:TO LINE Jack. An SF tone at -24 dBm is also connected to the SF Supervision controls to provide reverse supervision to the SF:TO EQUIP Jack.

3. TWD DROP/EQ -- this button, when engaed, connect the output of the SF Level control circuit to the SF Supervision Controls for gating by the Pulse Generator and connection to the SF:TO EQUIP Jack. An SF tone at -20 dBm is also connected to the SF Supervision Controls to provide reverse supervision to the SF:TO LINE Jack.

c. SF Supervision Controls -- The following six buttons, in conjunction with the SEND INTERFACE Controls, determine the type and direction of SF signaling. Two sets of identical buttons control the functions for TWD EQUIP or TWD LINE.

1. The three TWD EQUIP buttons determine the supervision for the SF:TO EQUIP Jack as follows:

ON HK -- When this button and the SEND INTERFACE:TWD DROP/EQ button are engaged, and SF tone of the level set on the SF LEVEL thumbwheels is sent on the TO EQUIP Jack. If this button and the SEDN INTERFACE:TWD LINE button are engaged, a fixed level of -20 dBm is sent on the TO EQUIP Jack. When the ON HK button is engaged, the SF:FROM LINE Jack is terminated in 600 ohms.

MON -- When this button is engaged, the SF:FROM LINE Jack is connected to the SF:TO EQUIP Jack. This allows monitor measurements to be made on the receive path of the SF circuit when the REC INTERFACE:FROM LINE button is engaged.

OFF HK & PULSE -- When this button and the SEND INTERFACE: TWD DROP/EQ button are engaged, the tone output of the SF Level control circuit is gated by the Pulse Generator output signal and sent on the SF:TO EQUIP Jack. If this button and the SEND INTERFACE:TWD LINE button are engaged, no tone (OFF HOOK) appears at the SF: TO EQUIP Jack. When this button is engaged, the SF:FROM LINE Jack is terminated in 600 ohms.

2. The three TWD LINE buttons determine the supervision for the SF:TO LINE Jack as follows:

ON HK -- When this button and the SEND INTERFACE:TWD LINE button are engaged, an SF tone of the level set on the SF LEVEL thumbwheels is sent on the TO LINE Jack. If this button and the SEND INTERFACE:TWD DROP/EQ button are engaged, a fixed level of -20 dBm is sent on the TO LINE Jack. When the ON HK button is engaged, the SF:FROM EQUIP Jack is terminated in 600 ohms.

MON -- When this button is engaged, the SF:FROM EQUIP Jack is connected to the SF:TO LINE Jack. This allows monitor measurements to be made on the local sending unit, without interrupting the circuit, when the REC INTERFACE: FROM DROP/EQ button is engaged.

OFF HK & PULSE -- When this button and the SEND INTERFACE: TWD LINE button are engaged, the tone output of the SF Level Control circuit is gated by the Pulse Generator output signal and sent on the SF:TO LINE Jack. If this button and the SEND INTERFACE:TWD DROP/EQ are engaged, no tone (OFF HOOK) appears at the SF:TO EQUIP Jack. When this button is engaged, the SF:FROM LINE Jack is terminated in 600 ohms.

d. SF LEVEL -- This two digit thumbwheel switch, part of the ADJUST SEND SIGNAL controls, selects the output level of the SF tone to be sent. The level is in -dBm with reference to the sending impedance.

e. SF IMP -- These three buttns select the sending impedance for the SF:TO EQUIP and SF:TO LINE Jacks. The receive impedance is always 600 ohms.

4.6.03 Circuit Connections

a. The four SF jacks are used to connect the Test Set to the SF circuit. To prevent service interruptions the REC INTERFACE and SF Suprvision buttons should be set to provide monitoring on a bringing basis described in Section 4.6.04. The FROM LINE and TO EQUIP jacks are the receive side jacks or the +7 TLP jacks. The TO LINE and FROM EQUIP jacks are the transmit side or the -16 TLP jacks.

4.6.04 SF Monitoring

a. The T222C has the ability to monitor the send or receive side of the 4-wire circuit on a high impedance basis. Three related functions (supervision status determination, pulse measurements, level and frequency measurements) may be performed by the set in the monitoring mode with the same buttns engaged. The following buttons are operated:

ENGAGED

REC INTERFACE:SF
*REC INTERFACE:FROM LINE or FROM DROP/EQ
SF Supervision:TWD LINE:MON
SF Supervision:TWD EQUIP:MON

*When the REC INTERFACE:FROM LINE is engaged, the received signals will

from the incoming or receiving side. When the FROM DROP/EQ button is engaged, the received signals will be from the local equipment or the transmit side.

b. The supervision of either the transmit or receive side is determined by engaging the REC INTERFACE button for the desired direction and observing the REC ON HK Lamp. The supervision is indicated as follows:

| Lamp | Supervision |
|---|---|
| ON | On Hook |
| OFF | Off Hook |
| PULSING | Pulsing |

c. Pulse measurements for either the transmit or the receive side are also determined by the engaged FROM LINE or FROM DROP/EQ button. When pulsing is received, the Test Set displays the measured parameters selected by the Display Control buttons.

d. Frequency and level are automatically measured and displayed when the set identifies an SF tone as a valid On Hook signal. Since the T222C uses 600 ohms as the reference for level measurements, the following correction factors need to be applied to the displayed LEVEL measurement. If the nominal circuit impedance is 900 ohms, subtract 2 dB from the displayed level to obtain the level in dBm, 600 ohm. If the nominal circuit impedance is 1200 ohms, add 1 dB to the displayed level to obtain the level in dBm, 1200 ohms. These corrections apply ONLY to level measurements made in the monitoring mode.

4.6.05 Terminated SF Measurements

a. The Test Set makes terminated measurements into a 600 ohm impedance. Since service must be interrupted to make terminated measurements, the circuit should be idle.

1. To make terminated measurements on the receive side - from the line - the following buttons are operated:

ENGAGED

REC INTERFACE:SF
REC INTERFACE:FROM LINE
*SF Supervision:TWD EQ
**SF Supervision:TWD LINE
Set SF LEVEL (thumbwheel) to 24.

*If the local equipment requires Off Hook supervision, the OFF HK & PULSE button is engaged; if On Hook is required, the ON HK button is engaged. Normally the OFF HK & PULSE

button is engaged.

**If the transmit side requires a through connection, the MON button is engaged; if not, select either the ON HK or the OFF HK & PULSE for the transmit side supervision. Normally the OFF HK & PULSE button is engaged.

2. To make terminated measurements on the transmit side - from the local equipment - the following buttons are operated.

ENGAGED

REC INTERFACE:SF
REC INTERFACE:FROM DROP/EQ
*SF Supervision:TWD LINE
**SF Supervision:TWD EQ
SF LEVEL (thumbwheel) to 24.

*If the line requires Off Hook Supervision, the OFF HK & PULSE button is engaged; if On Hook is desired, ON HK button is engaged. Normally OFF HK & PULSE is engaged.

**If the receive side requires a through connection, the MON button is engaged; if not, either ON HK or OFF HK & PULSE is engaged. Normally OFF HK & PULSE is engaged.

b. After engaging the correct buttons for the desired direction of measurements, the operation is the same for either direction. The REC ON HK Lamp indicates the supervision or pulsing that is being received. When pulsing is received, the Test Set displays the measured parameters selected by the Display Control buttons.

c. When the Test Set is used in the terminating mode and the SF circuit is idle (On Hook), the Test Set automatically measures and displays the Frequency and Level of the incoming tone. If the nominal impedance of the SF circuit being measured is 900 ohms, the measurement error due to the 600 ohm termination is only -0.17 dB. For a 1200 ohm circuit the error is -.48 dB. Since the T222C measures and displays only to ±1 dB, the inaccuracy due to the unmatched impedances cannot be observed and the displayed 600 serves only to indicate the terminating impedance.

### 4.6.06 Sending SF

a. The Test Set may be connected into the SF circuit with one of three selectable impedances: 600, 900 or 1200 ohms. The transmit section is dc blocked and transformer coupled. Since service must be interrupted for pulsing, the circuit should be idle.

1. To pulse the local equipment or receive side of the circuit the following buttons are operated:

ENGAGED

SEND INTERFACE:SF
SEND INTERFACE:TWD DROP/EQ
SF Supervision:TWD EQUIP:OFF HK & PULSE
*SF Supervision:TWD LINE
SF LEVEL:Set to 1 dBm (-8 dBm0 pulsing level)
SF IMP:(Set to correct impedance)

*If the line requires On Hook supervision, engage the ON HK button. Normally OFF HK & PULSE is engaged.

2. To pulse the line or transmit side of the circuit the following buttons are operated:

ENGAGED

SEND INTERFACE:SF
SEND INTERFACE:TWD LINE
SF Supervision:TWD LINE:OFF HK & PULSE
*SF Supervision:TWD EQUIP
SF LEVEL:Set to 24 dBm (-8 dBm0 pulsing level)
SF IMP:(Set to correct impedance)

*If the local equipment requires On Hook supervision, engage the ON HK button. Normally OFF HK & PULSE is engaged.

b. After engaging the correct buttons for the desred direction of pulsing, the operation is the same for both directions. Pulsing is determined by the operation of the Pulse Generator controls.

## 4.7 E&M OPERATION

4.7.01 General -- The E&M Section of the Test Set provides circuits for both outpulsing and detection on the E and M leads. The Line (L) & Drop (D) lamps located to the left & right of the E&M Supervision controls are operated by the solid state high impedance E and M lead detectors. The outpulsing is done by solid state E lead (ground and open) or M lead (battery and ground) pulsers. The receiving is done with solid state terminating detectors. The ability to monitor an E&M circuit is also provided. The monitoring is accomplished by the high impedance E&M detectors, which also drive the Line and Drop lamps. The Test Set can also be used to pulse and measure the Type II and Type III E&M circuits with the same procedure for Type I operation.

4.7.02 Description of Controls -- This section covers the controls that are used for E&M operation. The controls that are unique to E&M operation are color coded blue.

a. REC INTERFACE -- The following three buttons are used for E&M receiving.

1. E&M -- This button is used for all types of E&M circuits. It selects the E&M detectors and connects their output to the Measuring Circuits so the requested data can be calculated and displayed.

2. FROM LINE -- This button is used to select the line side detectors. When the button is engaged, the output of either the high impedance or the terminating E lead detector (determined by the position of the E&M:TWD DROP:MON Supervision button) is selected and connected to the Measuring Circuits by the E&M button.

3. FROM DROP/EQ -- This button is used to select the drop side detectors. When engaged, the output of either the high impedance or the terminating M lead detector (determined by the position of the E&M:TWD LINE:MON Supervision button) is selected and connected to the Measuring Circuits.

b. SEND INTERFACE -- The following three buttons are used to select the type and direction of E&M outpulsing.

1. E&M -- This button, when engaged, connects the Pulse Generator output to the E&M Send Interface and Supervision Controls for pulsing the E lead or M lead pulsing circuits.

2. TWD LINE -- This button, when engaged, connects the Pulse Generator output to the M lead pulser.

3. TWD DROP/EQ -- This button, when engaged, connects the Pulse Generator to the E lead pulser.

c. E&M Supervision Controls -- The following six buttons, in conjunction with the SEND INTERFACE controls, determine the supervision presented to the E&M:LINE and DROP jacks.

1. The three TWD DROP buttons determine the supervision for the E&M:DROP jack as follows:

ON HK -- When engaged, the Test Set sends an On Hook (open) on the tip (E lead) of the E&M:DROP jack. The tip of the E&M:LINE jack is terminated and the "L" (line) lamp displays the status of the line.

MON -- When engaged, the E lead is connected through the Test Set - the tip of the E&M:LINE jack is connected to the tip of the E&M:DROP jack. The high impedance E lead detector drives the LINE lamp and also drives the measuring circuits if the REC INTERFACE:FROM DROP/EQ button is engaged.

OFF HK & PULSE -- When engaged, the E lead from the E&M:LINE jack is terminated and an Off Hook (ground) is sent on the E lead of the E&M:DROP jack by the E lead pulser. If the SEND INTERFACE:TWD DROP/EQ button is engaged, the E lead pulser is controlled by the Pulse Generator output.

2. The three TWD LINE buttons determine the supervision for the E&M:LINE jack as follows:

ON HK -- When engaged, the Test Set sends an On Hook (ground) on the ring (M lead) of the E&M:LINE jack. The ring of the E&M:DROP jack is terminated and the "D" (drop) lamp displays the supervision from the drop.

MON -- When engaged, the M lead is connected through the Test Set - the ring of the E&M:LINE jack is connected to the ring of the E&M:DROP jack. The high impedance M lead detector drives the DROP lamp and also drives the measuring circuits if the REC INTERFACE:FROM LINE button is engaged.

OFF HK & PULSE -- When engaged, the M lead from the E&M:DROP jack is terminated and an Off Hook (battery) is sent on the M lead of the E&M:LINE jack by the M lead pulser. If the SEND INTERFACE:TWD LINE button is engaged, the M lead pulser is controlled by the Pulse Generator output.

4.7.03 Circuit Connections

a. The two E&M jacks are used to connect the Test Set to the E&M circuit. To prevent service interruptions the REC INTERFACE and E&M Supervision buttons should be set to provide monitoring on a bridging basis as described in Section 4.4.04 before patching to the circuit. The LINE jack is connected to the line side of the E&M circuit; the M lead pulser is on the ring of this jack and the E lead detectors are on the tip. The DROP jack is connected to the drop side of the E&M circuit; the E lead pulser is on the tip of this jack and the M lead detectors are on the ring.

4.7.04 E&M Monitoring

a. The Test Set has the ability to monitor the E lead and M lead on a high impedance (bridging) basis without affecting the performance of the circuit and without taking the circuit out of service. The following buttons are operated:

| ENGAGED |
| --- |
| REC INTERFACE:E&M |
| E&M Supervision:TWD LINE:MON |
| E&M Supervision:TWD DROP:MON |

b. The status of the E lead and M lead is indicated by the "L" and "D" lamps. Pulsing on either lead is measured and displayed by engaging the REC INTERFACE:FROM DROP/EQ or FROM LINE button and the desired Display Controls.

4.7.05 Terminated E&M Measurements

a. The Test Set makes terminated E&M pulse measurements into a 470 ohm impedance. Since service must be interrupted to make terminated measurements, the circuit should be idle.

1. To make terminated measurements on the E lead, from the line, the following buttons are operated:

| ENGAGED |
| --- |
| REC INTERFACE:E&M |
| REC INTERFACE:FROM LINE |
| *E&M Supervision:TWD DROP |

*Either the ON HK or the OFF HK & PULSE button is engaged depending on supervision to be sent toward the Drop. Normally the OFF HK & PULSE button is engaged.

2. To make terminated measurements on the M lead, from the drop, the following buttons are operated:

| ENGAGED |
| --- |
| REC INTERFACE:E&M |
| REC INTERFACE:FROM DROP/EQ |
| *E&M Supervision:TWD LINE |

*Either the ON HK or the OFF HK & PULSE button is engaged depending on supervision to be sent toward

the line. Normally the OFF HK & PULSE button is engaged.

b. After engaging the correct buttons for the desired measurement direction, the operation is the same for either direction. The REC ON HK lamp indicates the supervision or pulsing that is being received. When pulsing is received, the Test Set displays the measured parameters selected by the Display Control buttons.

4.7.06 Pulsing E&M

a. When pulsing E&M, the circuit has to be broken between the Line and Drop. It is recommended that the monitor test above be done to determine that the circuit is idle before pulsing tests are performed.

1. FOR PULSING THE LINE:

The following buttons are operated:

ENGAGED

SEND INTERFACE:E&M
SEND INTERFACE:TWD LINE
E&M Supervision:TWD LINE, OFF HK & PULSE

NOTE: Supervision toward the Drop can be accomplished by engaging the appropriate button under the E&M Supervision TWD DROP. If the Line is to supervise the Drop the TWD DROP:MON button should be engaged. Otherwise the OFF HK & PULSE button should be engaged.

2. For pulsing the drop:

The following buttons are operated:

ENGAGED

SEND INTERFACE:E&M
SEND INTERFACE:TWD DROP/EQ
E&M Supervision:TWD DROP, OFF HK & PULSE

NOTE: Supervision toward the Line can be accomplished by engaging the appropriate E&M Supervision buttons under the TWD LINE.

b. Now patch the Test Set to the circuit using the E&M LINE and DROP Jacks. The desired pulsing may now be performed by operating the appropriate ADJUST SEND SIGNAL and PULSING Controls.

## 4.8 DX OPERATION

4.8.01 General -- The DX Section interfaces the DX signaling system at the A & B Leads or the 2W tip and ring. The ability to monitor on an in-service or out-of-service basis is provided. In a DX signaling system the Line side is defined as the more distant DX unit and the Equipment side is the closer DX unit. This is the terminology in this operational section.

4.8.02 Description of Controls -- This section covers the controls that are used in DX operation. Those push buttons that are unique to DX operation are identified by a cream colored button.

a. REC INTERFACE -- The following four buttons are used for DX operation.

1. DX -- This button, when engaged, connects the output of either the high impedance DX detector or the low impedance DX receiver to the T222C measuring circuits.

2. STATUS -- This button is used to select the A/B Detector and the A/B Lamp when the status of the DX loop is to be determined.

3. FROM LINE and FROM DROP/EQ -- These two buttons select the direction for receiving or Status indication; either toward the line or toward the equipment.

b. SEND INTERFACE -- The following four buttons are used in the DX mode of operation.

1. DX -- This button, when engaged, connects the output of the Pulse Generator to the DX pulser.

2. ADD RES -- This button, when engaged, adds the amount of the ADD LOOP RESISTANCE buttons to the output of the DX Pulser. When switching from the EQUIP side to LINE side, only the ADD RES button needs to be used instead of changing all the Loop Resistance buttons.

3. TWD LINE & TWD DROP/EQ -- These two buttons select the direction of pulsing. The TWD LINE, when engaged, will present the pulsing on the A lead of the DX LINE jack. When the TWD DROP/EQ button is engaged, the pulsing is presented to the A lead of the DX EQUIP jack.

NOTE: When the REC INTERFACE:DX button is engaged, the REC INTERFACE direction controls override those of the SEND INTERFACE. For example; if the REC INTERFACE: FROM LINE button is engaged, the output of the DX Pulser is connected toward the equipment regardless of the SEND INTERFACE:TWD DROP/EQ and TWD LINE button positions.

c. DX Supervision Controls -- The following five buttons, determine the supervision and operation for the DX functions.

1. MON -- This button connects the DX:EQUIP and LINE jacks through the Test Set and connects the high impedance monitor to the circuit. When connecting into the DX circuit of unknown supervision state, the DX:MON button should be engaged.

2. PULSE & STATUS -- This button breaks the DX Loop and terminates each lead. This condition is used for pulsing, status determination or terminated DX receiving.

3. A/B:REV/NORM -- This button reverses the A & B Lead orientation. The released position is the normal orientation A lead on tip and B lead on ring. The engaged position is the reverse condition.

4. OFF HK/ON HK -- This button is used in conjunction with the DX MON button. This selects one of two high impedance DX Monitor Receivers in the set. The released position or ON HK is used to monitor the DX circuit when the receiving end is On Hook. The engaged position or OFF HK is used to monitor when the receiving end is Off Hook.

5. REV SUPV:OFF HK/ON HK -- This button selects the reverse supervision when operating in either the DX REC terminating or DX Pulsing modes. The released position (ON HK) places an ON HOOK (Ground) in reverse direction from the sending or receiving direction. The engaged position places an Off Hook or battery in the reverse direction.

4.8.03 Status Determination

a. Operation -- Two ways are available for determining the status of a DX Circuit. The first way, assumptions are made and the second way the circuit is broken and terminated. To determine the status of the circuit without interrupting it; is to assume that the A lead is on the tip and B lead is on the ring. Operate the following buttons:

| ENGAGED | RELEASED |
|---|---|
| REC INTERFACE:DX | DX Supervision:OFF HK/ON HK (ON HK) |
| DX Supervision:MON | DX Supervision:A/B (NORM) |

b. Plug the circuit into the DX:EQUIP and LINE jacks; the Equipment side to the EQUIP jack and the Line side to the Line jack. If the circuit is idle, the DX ON HOOK lamp will be lighted. If the DX ON HOOK lamp does not light, an A/B reverse check should be made. Engage the DX A/B REV button. If the DX:ON HOOK lamp lights then the circuit is idle but the A & B leads were reversed from normal. If the lamp does not light, then either the circuit is busy or a fault exists.

c. The second way of status determination requires that the circuit be broken; therefore, the circuit should be out of service to prevent the interruption of calls. Operate the following buttons:

| ENGAGE | RELEASED |
|---|---|
| REC INTERFACE:DX | DX Supervision:A/B(NORM) |
| DX Supervision:PULSE & STATUS | DX Supervision:REV SUPV |

d. Plug the circuit into the DX:EQUIP and LINE jacks as previously described.

e. To check the Equip side, engage the REC INTERFACE:FROM DROP/EQ and STATUS buttons; STATUS button is held in for the duration of this test. Observe the DX:ON HOOK and A/B lamps. If the lamp is lighted, the A/B leads are in the correct orientation. If the lamp is not lighted, then engage the A/B REV button; the lamp should now be lighted. When the correct orientation of the A/B leads is achieved, (lighted A/B lamp), then observe the DX:ON HK lamp. If the DX:ON HOOK lamp is lighted, the Equip side is On Hook. To observe the Line side, engage the REC INTERFACE:FROM LINE button and observe the DX:ON HOOK lamp. If it is lighted, then the Line side is On Hook. If while observing either the Line or Equip side the DX:ON HOOK lamp did not light, then that particular direction was sending an Off Hook.

4.8.04 High Impedance Monitoring

a. The ability to monitor pulsing on a high impedance basis is available in the T222C. There are two conditions at the receiving end that can exist on the DX circuit; either On Hook or Off Hook. To monitor with the receiving end On Hook the following

buttons are operated:

| ENGAGED | RELEASED |
|---|---|
| REC INTERFACE:DX<br>DX Supervision:MON | DX Supervision:OFF HK/ON HK<br>(ON HK) |

NOTE: The A/B REV button should be in the position for the correct orientation of the leads.

b. The DX:ON HOOK lamp indicates the supervision and pulsing of the circuit. The Display mode may now be selected for the information desired. If the receiving end is Off Hook, then engage the DX Supervision:OFF HK/ON HK button (OFF HK). The DX:ON HOOK lamp indicates the supervision or pulsing of the circuit and the display shows the pulses in response to the engaged Display Controls.

4.8.05 Terminated Receiving

a. The DX circuit may be terminated and receiving from either the Line or the Equip side may be performed. To receive terminated the following buttons are operated:

| ENGAGED | RELEASED |
|---|---|
| REC INTERFACE:DX<br>DX Supervision:PULSE & STATUS | SEND INTERFACE:DX |

NOTE: The A/B button should be in the position for correct orientation of the A/B leads. The DX Supervision:REV SUPV button should be set to the desired position; either ON HK, released, or OFF HK, engaged.

4.8.06 DX Pulsing

a. After a status determination test has been completed, the DX Circuit can be pulsed. The following buttons have to be operated.

| ENGAGED | RELEASED |
|---|---|
| SEND INTERFACE:DX<br>DX Supervision:PULSE & STATUS | REC INTERFACE:DX |

NOTE: The DX Supervision:A/B and REV SUPV buttons should be set to the appropriate positions. The ADD LOOP RESISTANCE buttons should be set to the positions to make up the correct line resistance in the DX Circuit.

b. Plug the circuit under test into the DX:EQUIP and LINE jacks. To pulse the Line side; remove the line resistance by releasing the ADD RES button, engage the SEND INTERFACE:TWD LINE button and operate the Send Controls for the desired pulsing. To pulse the Equip side; add the line resistance, by engaging the ADD RES button, engage the SEND INTERFACE:TWD DROP/EQ button and operate the Send Controls for the desired pulsing.

# 5.0 OPERATIONAL CHECKS

## 5.1 General

5.1.01 This section will cover the checks that may be made by the operator, using only a patch cord, to verify the operation of the Test Set. The individual sections are designed to check various portions of the Test Set to isolate problems for repair purposes.

5.1.02 Tolerance, where not specified, is ±2 count in the least significant digit.

## 5.2 Initial Conditions

5.2.01 The following procedure establishes the correct control positions so that the Test Set will "come up" in a known operating mode when power is applied.

a. Engage the following buttons:

DISPLAY CONTROL:MODE:MEAS:REC
REC INTERFACE:LOOP
SEND CONTROL:ON HK (Pulse Generator)
INTERDIGIT TIME:400+200+100

b. Set the POWER switch to the ON position. The LINE, REC ON HK, and the DX:ON HOOK lamps should be lighted and the word READY displayed.

c. If the PULSE and INTERDIGIT lamps are flashing, push the "*" key momentarily to stop pulsing.

d. If the word READY is not displayed, push the DISPLAY CONTROL: MODE, CLEAR button.

e. If the MANUAL lamp is not lit, press the "*" key for 2 seconds.

## 5.3 Pulse Generator and Display Checks

5.3.01 The Pulse Generator and the Display sections have to be checked together. This section is divided into various tests. Test A will verify the basic operation of the Pulse Generator. Test B will check the Pulse Generator, Measurements, and Display Sections for their Speed and % Break functions. Test C will check the Pulse Generator and Display for the proper keyboard operation and Dialed Number Display function. Test D will check the rest of the Display functions.

| TEST A | |
|---|---|
| Action | Result |
| 1. Engage the SEND CONTROL: DIGIT button. | |

| Action | Result |
|---|---|
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Press "0" key of Keyboard | The Pulse Lamp should pulse 10 times. The Interdigit Lamp should light after end of pulsing for a period of 700 ms and then go off. |
| 4. Press # Keyboard key | The Set should repeat pulsing 10 pulses with the interdigit interval. |
| 5. Press * Keyboard key momentarily | Pulsing stops. |

TEST B

| Action | Result |
|---|---|
| 1. Set the following buttons as indicated.<br><br><u>Engaged</u> --<br><br>DISPLAY CONTROL:<br>% BRK<br>PPS<br>MEAS:PULSE GEN<br>UPDATE<br>SEND CONTROL:<br>TRAIN<br><br><u>Released</u> --<br><br>DISPLAY CONTROL:<br>COUNT PULSES<br>DIALED NUMBER<br><br>2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |

| Action | Result |
|---|---|
| 3. Press "0" Keyboard digit | REC ON HK lamp should pulse and Display should read 60.0 %BK 12.0 PPS |
| 4. Set the ADJUST SEND SIGNAL: SPEED to 22. | Display: 60.0 %BK 22.0 PPS |
| 5. Set the ADJUST SEND SIGNAL: SPEED to 02. | Display: 60.0 %BK 02.0 PPS |
| 6. Set the ADJUST SEND SIGNAL: SPEED thumbwheel to each position from 02 to 09. | The Display should read the same PPS as the setting of the SPEED thumbwheel. |
| 7. Set the ADJUST SEND SIGNAL: SPEED thumbwheel to 05 and adjust the % BREAK thumbwheel to each position from 60 to 69. | The %BK portion of the Display should follow the setting of the % BREAK thumbwheel. |
| 8. Adjust the % BREAK thumbwheel to each position from 20 to 90 by 10's. | The %BK portion of the display should follow the setting of the % BREAK thumbwheel. |
| 9. Press * Keyboard key momentarily. | Pulsing stops. |

| TEST C | |
|---|---|
| Action | Result |
| 1. Engage the following buttons:<br><br>DISPLAY CONTROL:<br>DIALED NUMBER<br>MEAS:PULSE GEN<br>SEND CONTROL:<br>DIGIT | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Press "1" Keyboard digit | Display: 1 NMBR |

| Action | Result |
|---|---|
| 4. Press in succession keyboard "2" thru "0" | Display: 1234567890 NMBR |
| 5. Press DISPLAY CONTROL:CLEAR button. | Display: READY |

TEST D

| Action | Result |
|---|---|
| 1. Set the following buttons as indicated.<br><br>Engaged --<br><br>DISPLAY CONTROL:<br>WIDTH<br>PERIOD<br>MEAS:PULSE GEN<br>UPDATE<br>SEND CONTROL:<br>DIGIT<br><br>Released --<br><br>DISPLAY CONTROL:<br>COUNT PULSES<br>DIALED NUMBER | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Press "0" Keyboard digit | Display: 50.0 WID 83.3 PER |
| 4. Engage the DISPLAY CONTROL: AVG button. | |
| 5. Press "9" Keyboard digit | Display: 50.0 WID 83.3 PER AV* |
| 6. Engage the DISPLAY CONTROL: COUNT PULSES button and push the DISPLAY CONTROL: CLEAR button. | Display: READY |

TEST D Continued

| Action | Result |
|---|---|
| 7. Press "0" Keyboard digit | Display: 010 PULSES |
| 8. Release the DISPLAY CONTROL: COUNT PULSES button and push the DISPLAY CONTROL: CLEAR button. | Display: READY |
| 9. Press "0" Keyboard digit | Display:<br>50.0 WID 83.3 PER AV9 |
| 10. Push the DISPLAY CONTROL: PULSE DATA button. | Display:<br>50.0 WID 83.3 PER P#1 |
| 11. Push the DISPLAY CONTROL: CLEAR button. | Display: READY |

## 5.4 LOOP Checks

5.4.01 This section will cover the tests which can be performed to verify the operation of the Loop Interface Send and Receive sections. Test A will verify the Loop Receivers and Loop Contact Closure Pulser. Test B will check the Battery and Ground Pulser.

TEST A

| Action | Result |
|---|---|
| 1. Set the following buttons as indicated.<br><br>Engaged --<br><br>DISPLAY CONTROL:<br>% BRK<br>PPS<br>MEAS:REC<br>AVG<br>SEND CONTROL:<br>DIGIT<br>ADD LOOP RESISTANCE:<br>400<br>800<br>LEAK COND:<br>OUT<br>"A"<br>SEND INTERFACE:<br>LOOP<br>REC INTERFACE:<br>LOOP | |

| Action | Result |
|---|---|
| Released --<br><br>DISPLAY CONTROL:<br>COUNT PULSES<br>DIALED NUMBER<br>SEND INTERFACE:<br>B&G/NORM<br>REC INTERFACE:<br>"A" RLY/DIRECT | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Push the DISPLAY CONTROL: CLEAR button. | Display: READY |
| 4. Patch the LOOP:SEND jack to the LOOP:TERM REC jack. | REC ON HK Lamp is no longer lighted. |
| 5. Press "0" Keyboard digit | Display:<br>60.0 %BK 12.0 PPS AV9 |
| 6. Release the LEAK COND: OUT button and engage the REC INTERFACE:"A"RLY/DIRECT button. | |
| 7. Press "0" and then the "#" Keyboard keys. | Display: 60.0 %BK ±.5%BK<br>12 PPS AV9 |
| 8. Press "*" Keyboard key. | Pulsing stops. |
| 9. Move the patch cord from the LOOP:SEND jack to the LOOP: S/R jack. | |
| 10. Push the DISPLAY CONTROL: CLEAR button. | Display: READY |
| 11. Press "0" and then the "#" Keyboard keys. | Display: 60.0 %BK ±.5%<br>12 PPS AV9 |
| 12. Press "*" Keyboard key. | Pulsing stops. |

TEST B

| Action | Result |
|---|---|
| 1. Set the following buttons as indicated. | |

| Action | Result |
|---|---|
| Engaged --<br><br>DISPLAY CONTROL:<br>%BRK<br>PPS<br>MEAS:REC<br>AVG<br>SEND CONTROL:<br>DIGIT<br>ADD LOOP RESISTANCE:<br>3.2k<br>400<br>200<br>LEAK COND:<br>OUT<br>SEND INTERFACE:<br>B&G/NORM<br>LOOP<br>REC INTERFACE:<br>LOOP<br><br>Released --<br><br>DISPLAY CONTROL:<br>COUNT PULSES<br>DIALED NUMBER<br>REC INTERFACE:<br>"A" RLY/DIRECT | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Push the DISPLAY CONTROL: CLEAR button. | Display: READY |
| 4. Press "0" and then the "#" Keyboard keys. | Display:<br>60.0 %BK 12.0 PPS AV9 |
| 5. Press "*" Keyboard key. | Pulsing stops. |

5.5 E&M Checks

5.5.01 This section will cover the tests which may be performed to verify the operation of the E&M Send and Receive functions.

| TEST A | |
|---|---|
| Action | Result |
| 1. Set the following buttons as indicated. | |

| Action | Result |
|---|---|
| Engaged --<br><br>DISPLAY CONTROL:<br>% BRK<br>PPS<br>MEAS:REC<br>UPDATE<br>SEND CONTROL:<br>DIGIT<br>SEND INTERFACE:<br>E&M<br>TWD DROP/EQ<br>E&M Supervision:<br>TWD DROP:OFF HK & PULSE<br>TWD LINE:ON HK<br>REC INTERFACE:<br>E&M<br>FROM LINE | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Patch the E&M:LINE jack to the E&M:DROP jack. | The LINE lamp and REC ON HOOK lamp go out. |
| 4. Press "0" and then the "#" Keyboard keys. | DISPLAY:<br>60.0 %BK 12.0 PPS<br>The LINE and REC ON HK lamps pulse. |
| 5. Press "*" Keyboard key. | Pulsing stops. |
| 6. Engage the E&M:TWD DROP: ON HK superfision button. | The REC ON HK and LINE lamps light. |
| 7. Engage the following buttons:<br><br>SEND INTERFACE:<br>TWD LINE<br>E&M:TWD LINE:OFF HK<br>& PULSE<br>REC INTERFACE:<br>FROM DROP/EQ | |
| 8. Press "0" and then the "#" Keyboard keys. | DISPLAY:<br>59.9 %BK 12.0 PPS<br>REC ON HK and DROP lamps pulse. |
| 9. Engage the E&M:TWD LINE: ON HK Supervision button. | DROP & REC ON HK lamps light. |

| | |
|---|---|
| 10. Press "*" Keyboard key. | Pulsing stops. |

5.6 SF Checks

5.6.01 The following test will allow the operator to check the SF Send and Receive sections for pulsing operation and the measurement of frequency and level.

| TEST A | |
|---|---|
| Action | Result |
| 1. Set the following buttons as indicated:<br><br>Engaged --<br><br>DISPLAY CONTROL:<br>% BRK<br>PPS<br>MEAS:REC<br>AVG<br>SEND CONTROL:DIGIT<br>SF IMP:900<br>SF FREQ:2600<br>SEND INTERFACE:<br>SF<br>TWD DROP/EQ<br>SF Supervision:<br>TWD EQUIP:OFF HK & PULSE<br>TWD LINE:OFF HK & PULSE<br>REC INTERFACE:<br>SF<br>FROM LINE<br><br>Released --<br><br>DISPLAY CONTROL:<br>COUNT PULSES<br>DIALED NUMBER | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60<br>SF LEVEL -- 13 | |
| 3. Patch the SF:TO EQUIP jack to the SF:FROM LINE jack. | |
| 4. Press "0" and then the "#" Keyboard keys. | DISPLAY:<br>60.1 ± .5 %BK 12.0 PPS AV9 |

TEST A Continued

| Action | Result |
|---|---|
| 5. Press "*" Keyboard key. | Pulsing stops. |
| 6. Engage the supervision SF:TWD EQUIP:ON HK button. | DISPLAY:<br>FREQ = 2600 Hz; ±5 Hz<br>LEVEL = -13 dBm (600) ±1 dB |
| 7. Engage the SEND INTERFACE: TWD LINE button. | DISPLAY:<br>FREQ = 2600 Hz; ±5 Hz<br>LEVEL = -20 dBm (600) ±1 dB |
| 8. Engage the REC INTERFACE: FROM DROP/EQ button. | REC ON HK lamp goes out. |
| 9. Patch the SF:TO LINE jack to the SF:FROM EQUIP jack. | |
| 10. Press "0" and then the "#" Keyboard keys. | DISPLAY:<br>60.1 ±.5 %BK 12.0 PPS AV9 |
| 11. Press "*" Keyboard key. | Pulsing stops. |
| 12. Engage the supervision SF:TWD LINE:ON HK button. | DISPLAY:<br>FREQ = 2600 Hz; ±5 Hz<br>LEVEL = -13 dBm (600) ±1 dB |

## 5.7 DX Checks

5.7.01 The following test will allow the operator to verify the operation of the DX Send and Receive sections.

TEST A

| Action | Result |
|---|---|
| 1. Set the following buttons as indicated.<br><br>Engaged --<br><br>DISPLAY CONTROL:<br>% BRK<br>PPS<br>MEAS:REC<br>AVG<br>SEND CONTROL:<br>DIGIT<br>ADD LOOP RESISTANCE:<br>1.6k<br>400<br>SEND INTERFACE:<br>DX | |

TEST A Continued

| Action | Result |
|---|---|
| TWD LINE<br>ADD RES<br>REC INTERFACE:<br>DX<br>FROM DROP/EQ<br>DX SUPERVISION<br>PULSE & STATUS<br><br>Released --<br><br>DISPLAY CONTROL:<br>COUNT PULSES<br>DIALED NUMBER | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Patch the DX:LINE jack to the DX:EQUIP jack. | REC ON HK Lamp will go out. |
| 4. Press "0" and then the "#" Keyboard keys. | DISPLAY:<br>60.0 %BRK 12.0 PPS AV9<br>DX:ON HOOK and REC ON HK Lamps are pulsing. |
| 5. Press "*" Keyboard key. | Pulsing stops. |
| 6. Engage the SEND INTERFACE: SF button. | |
| 7. Engage the DX:REV SUPV button. | DX:ON HOOK and REC ON HK Lamps are not illuminated. |
| 8. Release the DX:REV SUPV button. | DX:ON HOOK and REC ON HK Lamps are illuminated. |
| 9. Press the REC INTERFACE: STATUS button. | A/B Lamp illuminates while the STATUS button is pressed. |

## 5.8 Dialed Number Storage Checks

5.8.01 The following test will allow the operator to verify the operation of the Dialed Number Storage Section.

| Action | Result |
|---|---|
| 1. Set the following buttons as indicated.<br><br>Engaged --<br><br>DISPLAY CONTROL:<br>DIALED NUMBER<br>MEAS:PULSE GEN<br>INTERDIGIT TIME:400+200+100<br>SEND CONTROL:DIGIT | |
| 2. Set the ADJUST SEND SIGNAL controls as follows:<br><br>SPEED -- 12<br>% BREAK -- 60 | |
| 3. Press the "*" key for 2 seconds. | Store lamp lights, manual lamp turns off. |
| 4. Enter the following digits:<br>1234567890123456 | |
| 5. Press the "#" (send) key. | DISPLAY:<br>1234567890123456 |
| 6. Press the PULSE DATA button. | DISPLAY:<br>I.D. TIME = 700 msec±3msec<br>I.D. #1 |
| 7. Repeat step (6) 15 times. | |
| 8. Press the CLEAR key. | |
| 9. Press "*" momentarily. | |
| 10. Enter the following digits:<br>123 | |
| 11. Press the "#" key. | DISPLAY:<br>123 |